

MULTIMEDIA



UNIVERSITY

STUDENT ID NO

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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2022/2023 (TERM ID 2220)

ERR2236 – ROBOTICS – MODELLING AND CONTROL
(EC01)

3 JULY 2023
9.00 AM – 10.30 AM
(1.5 Hours)

INSTRUCTIONS TO STUDENT

1. This is an Open Book exam, you may bring and refer to your Lecture Slides during the exam.
2. This Question paper consists of 4 pages including cover page with 3 Questions only.
3. Attempt all questions. The distribution of the marks for each question is given.
4. Please print all your answers in the answer Booklet provided.

Question 1

Referring to Figure Q1, which shows a section of a robotic manipulator.

- (a) Find the homogenous transform matrix ${}^A_B T$ which map frame $\{B\}$ to frame $\{A\}$. Frame $\{B\}$ is obtained from frame $\{A\}$ by rotation on Z_A axis by $+20^\circ$ and translation offset by ${}^A P_{BORG}$. Then, calculate the coordinate of point ${}^A P$ using the homogenous transform matrix.
- (b) If the origin of frame $\{B\}$ is moving along X_A direction at 0.1 m/second with respect to $\{A\}$, and frame $\{B\}$ is rotating on Z_B axis at $+10^\circ/\text{second}$, what is the velocity at point P with respect to frame $\{A\}$? *Hint: convert angular velocity to radian/second. Use velocity transformation equation or velocity propagation rule.*

[6 + 9 marks]

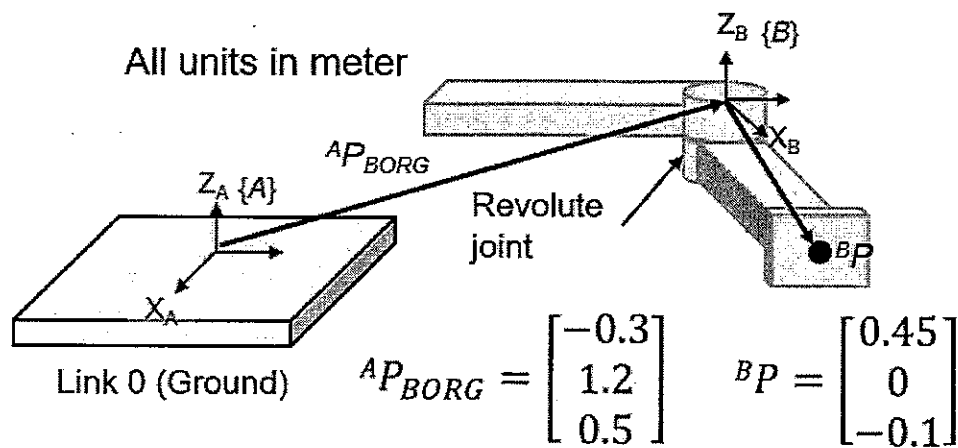


Figure Q1.

Continued...

Question 2

Figure Q2 shows a three-axis PRR robotic arm with four links.

- Sketch the robotic arm on your answer sheet and indicate the axis of movement for each joint.
- Using the Denavit-Hartenberg (DH) convention, assign suitable coordinate frames to each link, use the notations $\{0\}$, $\{1\}$, $\{2\}$, $\{3\}$ and $\{4\}$ for the coordinate frames from link 0 (ground) to link 3. The suggested orientation and location for frame $\{0\}$ is already indicated in Figure Q2. Origin of frame $\{4\}$ should coincide with point P .
- Based on your coordinate frames in part (b), write down the homogenous transformation matrix for ${}^0_1T$ and ${}^1_2T$.

[3 + 4 + 8 marks]

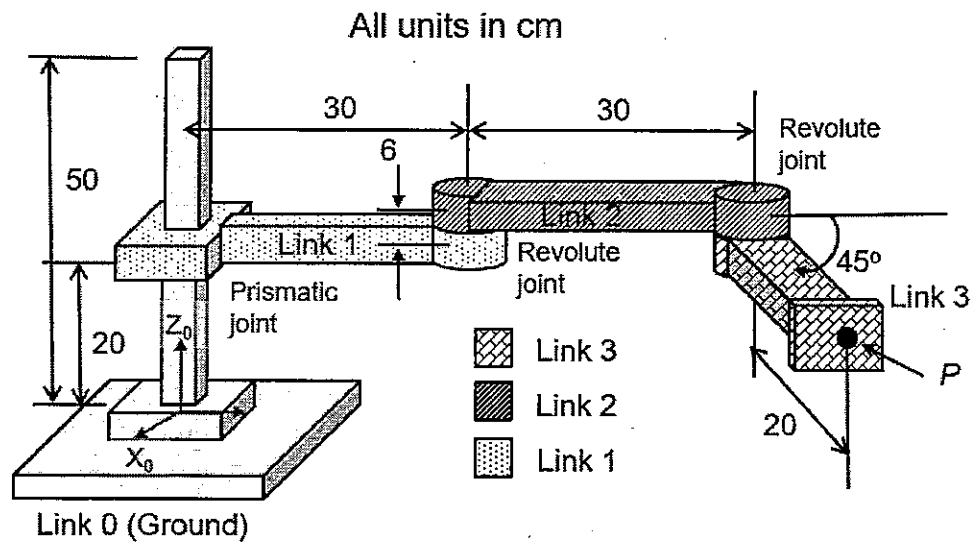


Figure Q2.

Continued...

Question 3

Consider the 4-axis RRRP robotic manipulator in Figure Q3.

- Sketch out the workspace of the robotic manipulator.
- If the robotic manipulator is to reach the point P in Figure Q3, sketch out TWO (2) configurations how the joints and links must be orientated in space to reach point P .
- Briefly explain what is singularity in robotic manipulator. Give an example of the configuration of the links for this robotic manipulator that will result in singularity.

[3 + 4 + 3 marks]

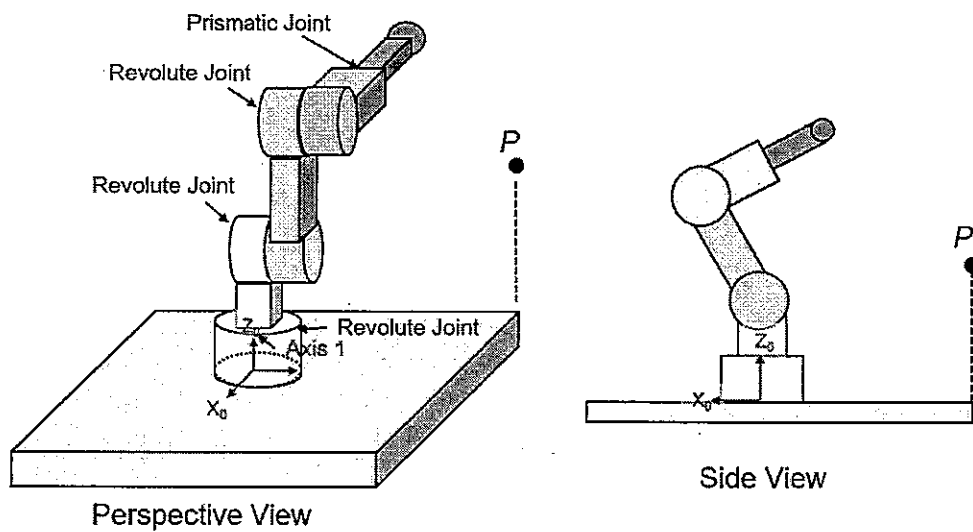


Figure Q3.

End of Paper.